

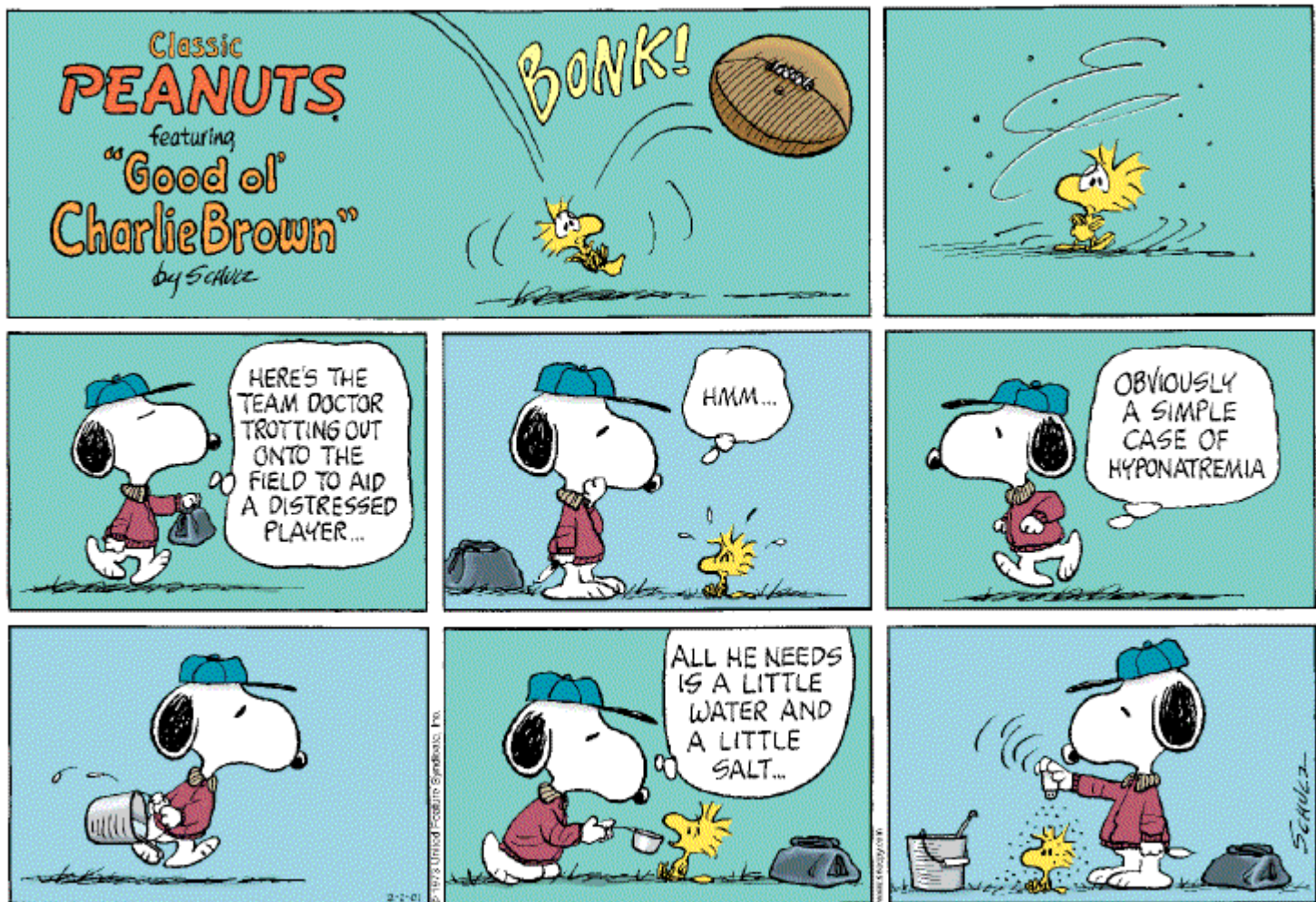
Pediatric Fluid & Electrolyte Management



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Objectives

- Relate maintenance fluid and electrolyte needs to metabolic rate rather than to body weight.
- Recognize the differences in mild, moderate, and severe deficits among infants compared with children or adults when expressed as percentage of body weight.
- Describe the indication for a "bolus" and specify the amount and composition.
- Specify a rehydration plan without the use of a calculator for an infant who has moderate dehydration.
- List the measures most valuable for monitoring the state of hydration.



Introduction

Parenteral fluid therapy is a basic component of the care of hospitalized infants and children

- assess the need for parenteral fluid therapy
- specify the composition of fluid and rate of administration

Introduction

Consider **separately** the amount of fluid needed and the electrolyte composition for:

- maintenance needs
- deficit
- ongoing losses

Because maintenance is not as directly related to weight as deficit or as directly measureable as ongoing losses, it is most confusing

Maintenance: Fluid

- Maintenance fluid and electrolyte needs stem from basal metabolism
- Metabolism creates two by-products, heat and solute, that need to be eliminated to maintain homeostasis

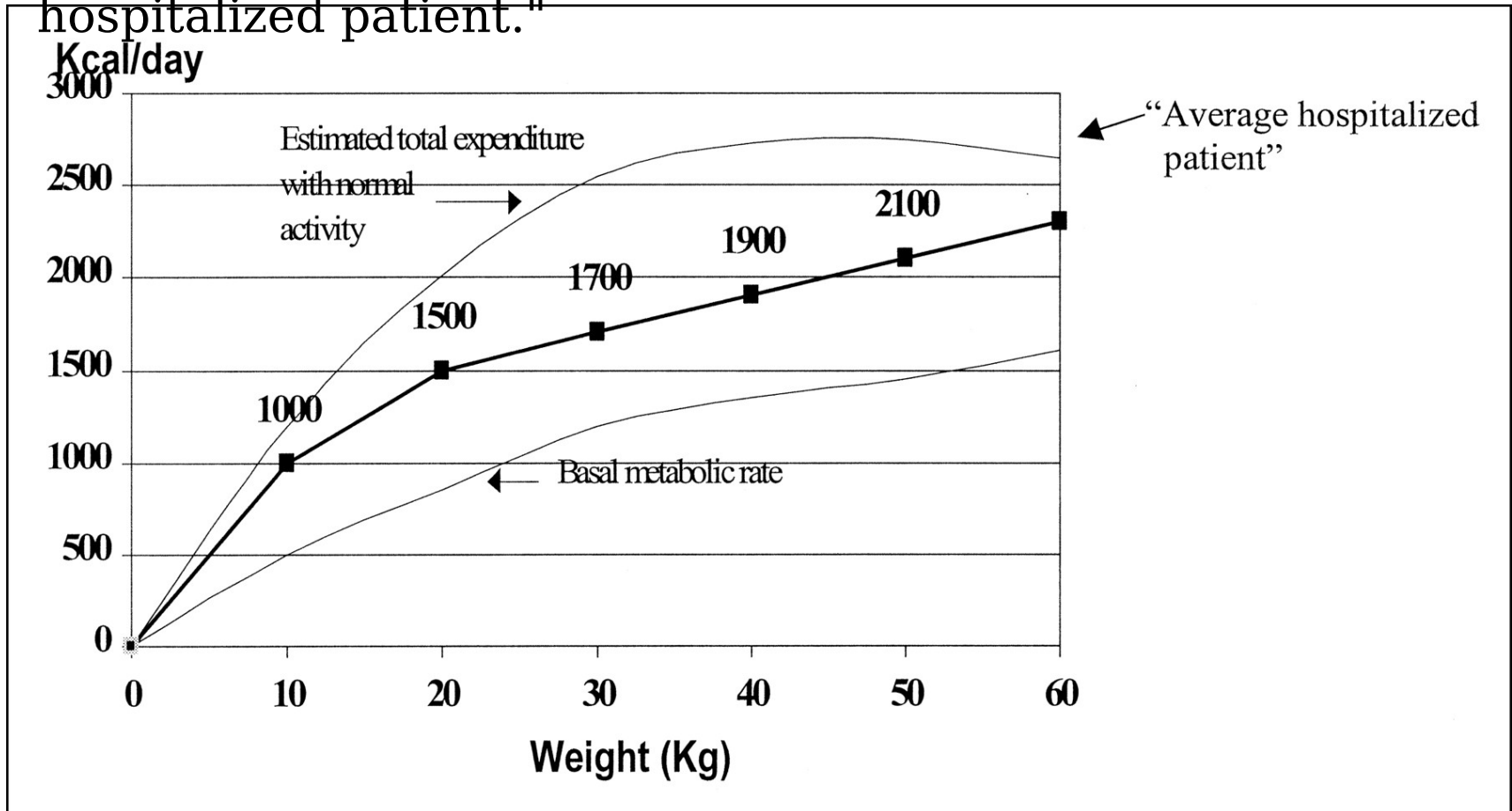
Maintenance: Fluid

- Heat is dissipated largely by the insensible evaporation of water from the skin surface
 - Active "sensible" skin loss—sweating—is added only when there is an additional heat burden and is not considered part of maintenance
- Elimination of warmed water vapor from the upper respiratory tract during exhalation also contributes to insensible fluid loss
- Soluble waste by-products of metabolism are excreted in the urine

Maintenance: Fluid

- Metabolic rate is not related directly to weight and is expressed in units of energy (kcal or joules)
- When compared with body weight, basal metabolic rate is high in the newborn period and much lower in adulthood, and the transition is not linear

Basal metabolic rate, estimated total expenditure with normal activity, and caloric expenditure of the "average hospitalized patient."



Although the amount of fluid and electrolytes declines per unit of body weight, it remains constant per kilocalorie of basal metabolism

Maintenance: Fluid

- Because it is difficult to remember basal metabolic rates for various ages and sizes during childhood, several methods have been proposed to relate maintenance needs to body weight, including:
 - the surface area method,
 - the basal calorie method, and
 - the Holliday-Segar system

Maintenance: Fluid

- The surface area method
 - requires a table to determine surface area and ideally knowledge of the patient's height and weight
 - different proponents advocate different estimates of fluid to be administered per m²
 - the system does not address deviations from normal activity

Maintenance: Fluid

- The basal calorie method
 - also requires a table
 - involves the most calculations
 - "drier" than the other methods

Maintenance: Fluid

- The Holliday-Segar system
 - does not address deviations from normal activity
 - used most frequently because of the ease with which the formula can be remembered and applied

Holliday-Segar Formula for Determining Calories (and Fluid Volume) for "Average Hospitalized Patient" at Maintenance

Weight (kg)	kcal/d or mL/d	kcal/h or mL/h
0 to 10 kg	100/kg per day	4/kg per hour
11 to 20 kg	1,000 + (50/kg per day) ¹	40 + (2/kg per hour) ¹
>20 kg 1,500 +	(20/kg per day) ²	60 + (1/kg per hour) ²

¹ For each kg >10.

² For each kg >20.

From Holliday MG, Segar WE. The maintenance need for water in parenteral fluid therapy. *Pediatrics*. 1957;19:823-832.

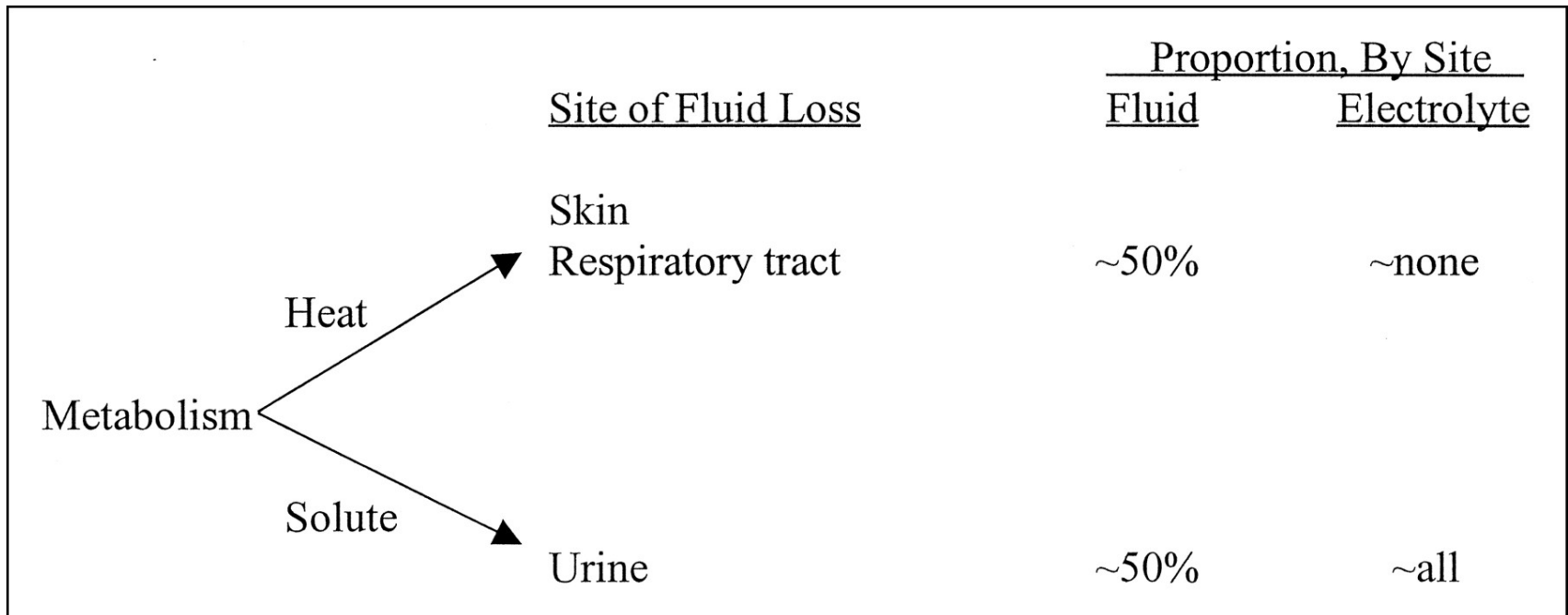
Maintenance: Fluid

- The Holliday-Segar formula estimates kilocalories
- For practical purposes, kilocalories = milliliters of fluid
 - For each 100 kcal expended, approximately 50 mL of fluid is required to provide for skin, respiratory tract, and basal stool losses, and 55 to 65 mL of fluid is required for the kidneys to excrete an ultrafiltrate with a specific gravity of 1.010
 - The sum generally is rounded to 100 mL of fluid per 100 kcal expended, permitting kilocalories and milliliters to be used interchangeably

Maintenance: Fluid

- The two functions of maintenance fluid (heat dissipation through insensible losses and solute excretion in urine) each represent 50% of maintenance needs
 - This principle is a great aid in the management of children who have anuric renal failure
 - Maintenance fluid needs decrease by 50% because the only fluids needing to be replaced are insensible losses

Maintenance fluid and electrolytes are required because of losses that stem from basal metabolism.



Approach to a Fluid and Electrolyte Problem

	Fluid (Amount of Water)	Electrolytes (Composition)
Maintenance	Determined by a "system": Holliday-Segar formula, surface area, or basal calorie method	D ₅ 0.2NS + 20 mEq/L K ⁺
Deficit	Determined by acute weight change or clinical estimate	Determined by tables (generally D ₅ 0.45NS + 20 mEq/L K ⁺)
Ongoing Losses	Determined by measuring	Determined by tables or measuring

Table 3. Relationship of Intake and Urine Output in a 10-kg Child Receiving Various Volumes of Fluid¹

	At Maintenance	More Than Maintenance	Less Than Maintenance
Volume	1,000 mL	2,000 mL	750 mL
Insensible loss	500 ml	500 ml	500 ml
Fluid available for urine	500 ml	1,500 ml	250 ml

¹ Note that urine output is half of intake only if the maintenance amount is provided.

Table 5. Two Methods of Rehydration¹

	Combined Deficit/Maintenance	Sequential Deficit/Maintenance
First 8 hours after bolus	remaining deficit + daily maintenance = 367 mL	Remaining deficit: 400 mL
Next 16 hours	remaining deficit + daily maintenance = 533 mL	Daily maintenance: 500 mL
Total	900 mL	900 mL

¹ A 5-kg infant who has moderate dehydration (10%, 500 mL deficit) following a 20 mL/kg bolus (100 mL). Remaining deficit is 400 mL; maintenance is 500 mL/d.